UCRL-PRES-149903-rev1

Misuse of Radioactive Material: First Responder Considerations

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First Responder Considerations

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KEY POINTS TO REMEMBER

- A "Dirty Bomb" is conventional explosives combined with radioactive material
- This is **NOT** a nuclear explosion, the radioactive material does not enhance the explosion.
- Very few deaths would be expected from acute radiological exposure (the greatest hazard would likely be from the effects of the conventional explosives).
- First Responders can safely manage these events.
- The contamination will hamper emergency response efforts and can delay hospital treatment of casualties.
- Widespread contamination can have a significant psychological and financial impact.

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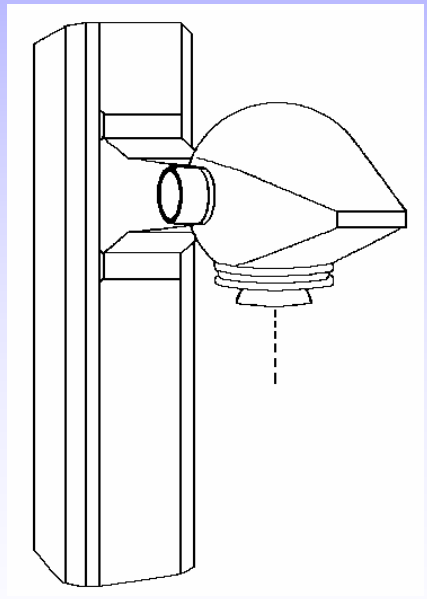
A Case Study: Goiania, Brazil 1987

- When a hospital changed locations, a radiation therapy unit was temporarily left behind.
- Scrap metal hunters found the unit and dismantled it for scrap metal (~ Sept 18th).
- The 1.4 kiloCi (1,400 Ci) Cs-137 source containment was breached during the process.
- Pieces of source distributed to family and friends.
- Everyone was impressed by "the glowing blue stones." Children and adults played with them.
- Serious radiological accident recognized on Sept 29th when Acute Radiation Syndrome symptoms where recognized by hospital staff.



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Initial Response

112,000 people (10 % of Goiania's population) were surveyed at an Olympic Stadium.

- **250 were identified as contaminated**
- **50 contaminated people were isolated in a camping area inside the Olympic Stadium for more detailed screening**
- **20 people were hospitalized or transferred to special housing with medical and nursing assistance**
- **8 patients transferred to the Navy Hospital in Rio de Janeiro**
- **Residential contamination survey was initiated**

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Early Consequences

- Widespread contamination of downtown Goiania
- 85 residences found to have significant contamination (41 of these were evacuated and a few were completely or partially demolished)
- People cross-contaminated houses 100 miles away
- Hot Spots at 3 scrap metal yards and one house

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Radiation Injuries and Uptakes

- 4 fatalities (2 men, 1 woman and 1 child)
- 28 patients had radiation induced skin injuries (they held/played with the source for extended periods)
- 50 people had internal deposition (ingestion)

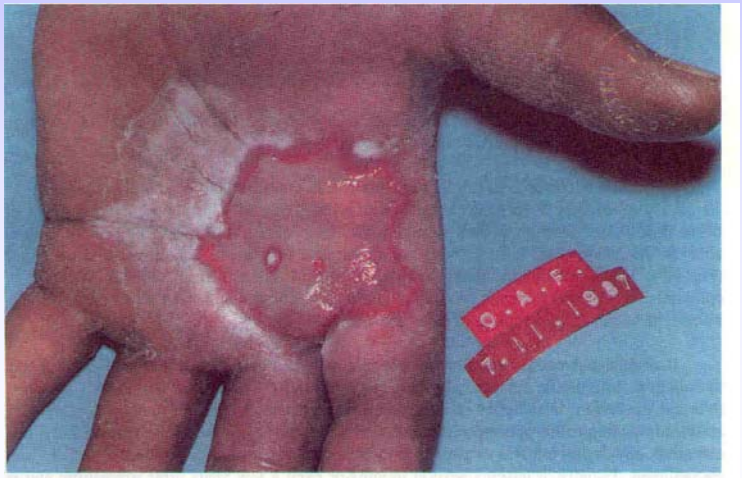
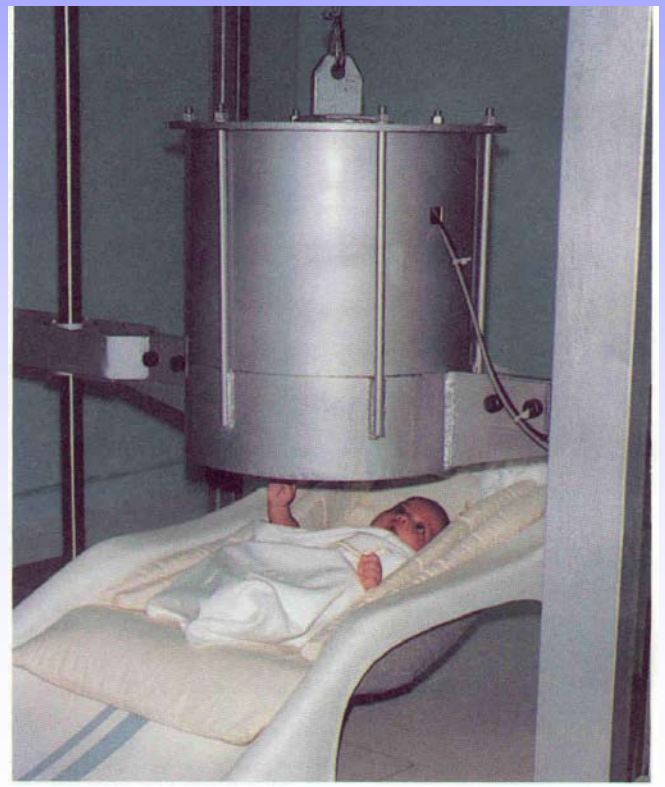


FIG. 9.3. 3–30 days after exposure. The skin was excised. A raw reddish surface is covered with a delicate layer of fibrinous exsudate. Note the centripetal character of the healing process and the attempt of re-epithelialization.



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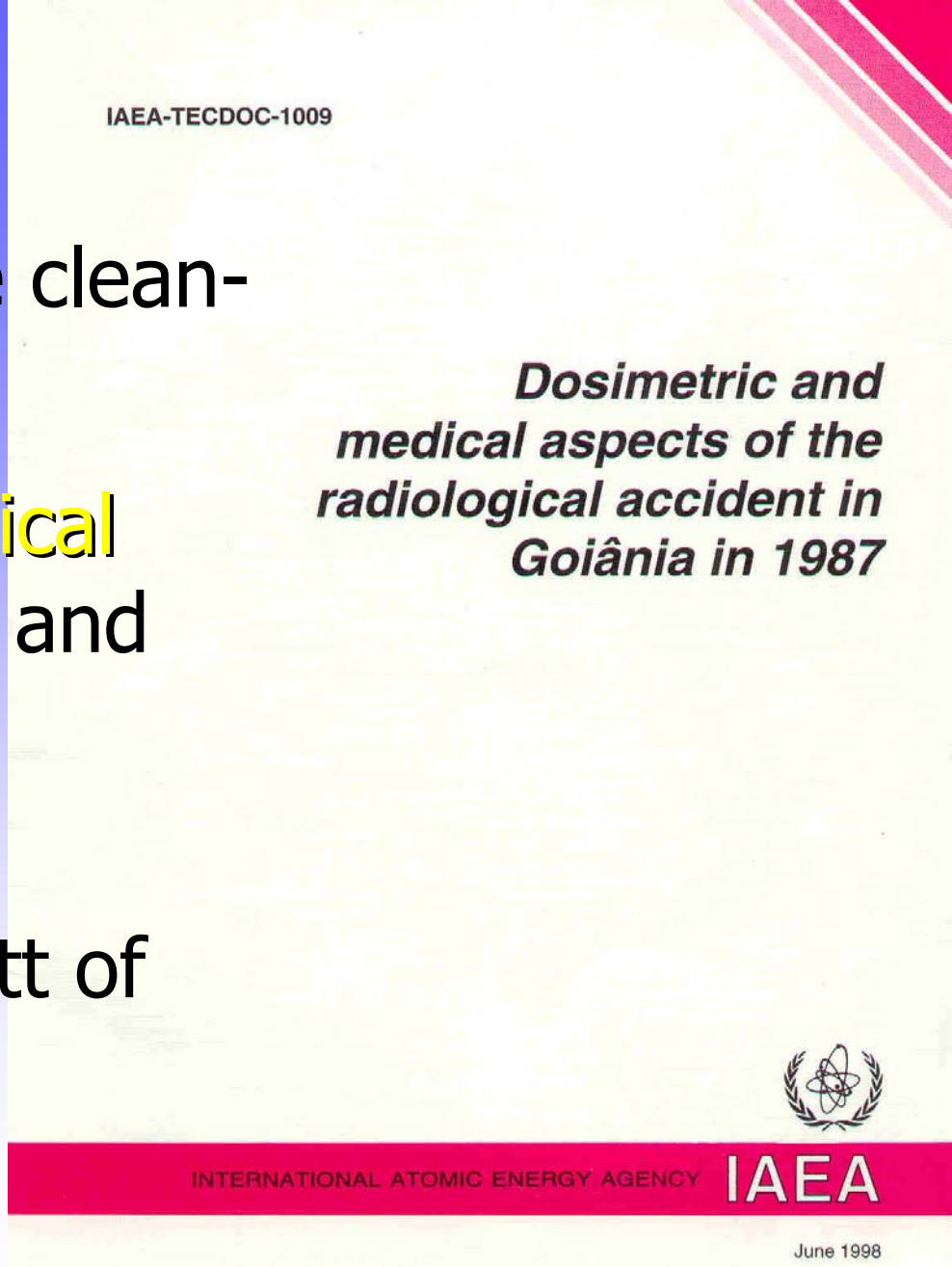
Conclusions

- Long and expensive clean-up effort.
- Profound psychological effects such as fear and depression on large populations
- Isolation and boycott of goods by neighbors



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Radiological Considerations for Public Protective Actions

- EPA-established radiological ***public*** dose action levels to facilitate decision making
- Based on projected dose levels at which specific protective actions are warranted to reduce or eliminate the dose ***which is yet to be received***
  - Early Phase
    - Actions that need to be initiated quickly
    - Dose projected to those standing outside over the first 4 days
    - Evacuation, sheltering, administration of stable iodine
  - Intermediate Phase
    - Actions can be taken weeks to months after the accident
    - Dose projections to those living in the contaminated areas
    - Relocation, actions to avoid ingestion of contaminated foods

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Protective Action Guides (PAG)

- Early Phase
  - 4 day exposure to cloud ("plume") immersion, cloud inhalation, groundshine, and resuspension:
    - 1 REM: consider evacuation or sheltering
    - 5 REM: consider evacuation
    - 25 REM Thyroid Dose: consider administration of stable iodine
- Intermediate Phase
  - Exposure to groundshine and resuspended material
    - 2 REM in first year, 0.5 REM in "second" year, 5 REM in first 50 years are levels at which relocation should be considered
  - Dose from ingestion
    - Expressed as deposition Derived Response Levels (DRL/DIL)
    - "Preventative" levels: 0.5 REM (1.5 REM Thyroid Dose)
    - "Emergency" levels: 5 REM (15 REM Thyroid Dose)

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As an Example, if Brazil's Source was used as a "Dirty Bomb"

- This model makes unrealistic assumptions:
  - The source was 100% aerosolized
  - Lots of explosives (> 10 sticks of dynamite)
  - Presumes exposed populations "stood outside" during the 4 day exposure period

- Despite the accident in Brazil, sources of this strength are very difficult to obtain.

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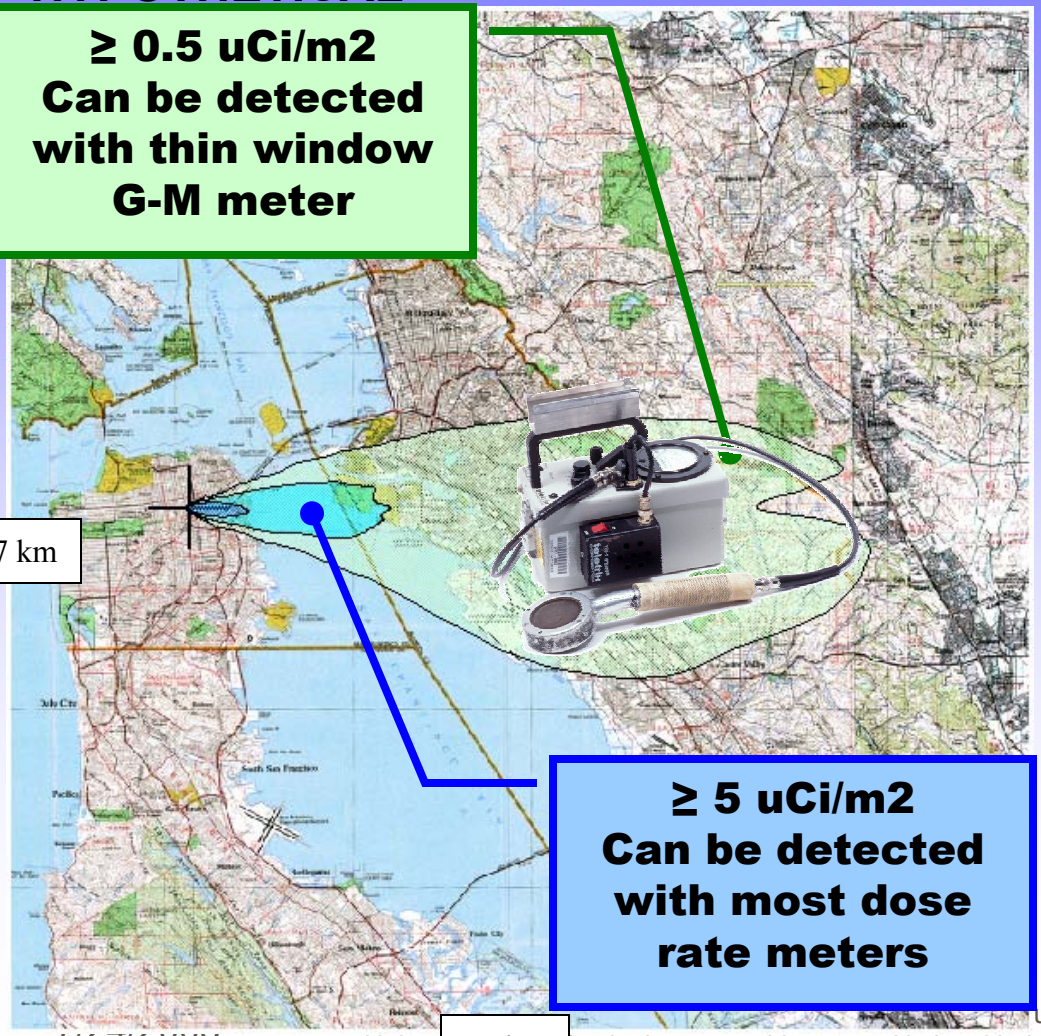
San Francisco Example: Ground Contamination Can be Detected East of Berkeley Hills

HYPOTHETICAL

≥ 0.5 uCi/m2 Can be detected with thin window G-M meter



Release: Cs-137, 1375 Ci aerosolized Deposited Contamination

Color	Level (uCi/m^2)	Area (km^2)	Description
	50	1.99	Population: 14,000 Take measures to prevent cross contamination
	5	24.43	Population: 24,000 Detectable with "hot dog" GM
	0.5	361.9	Population: 534,000 Detectable with "Pancake" GM

Release location: West of The Civic Center, San Francisco, CA
37° 46' 44" N 122° 25' 22" W

Winds near surface 10-15 mph from West.

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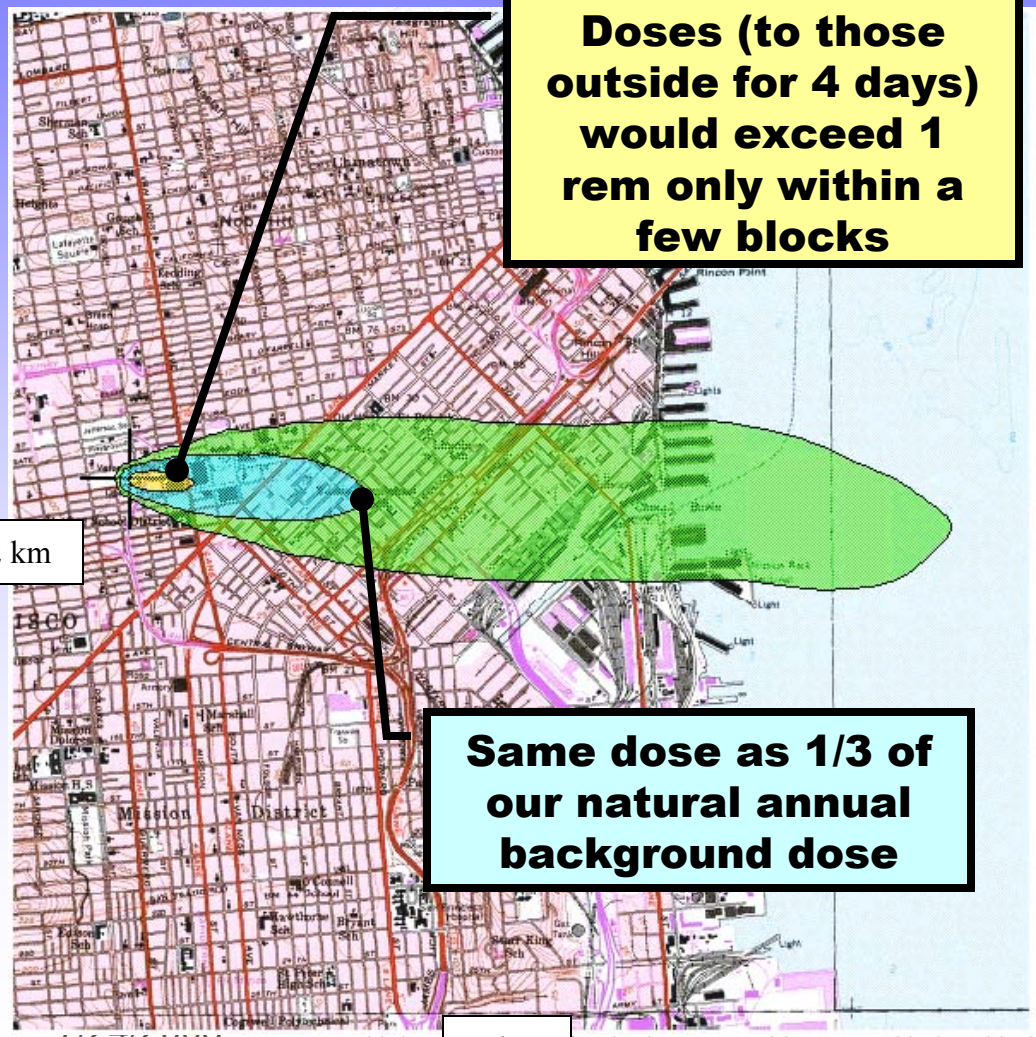
Despite the widespread contamination, the EPA PAG Would Recommend Shelter of only a Few Residential Blocks



HYPOTHETICAL

Release: Cs-137, 1375 Ci aerosolized
4-Day TEDE,
Evacuation/Relocation PAG

Color	Level (Rem)	Area (km^2)	Description
	1	0.038	Population: 540 EPA guide for Shelter in place (No acute radiological effects)
	0.1	0.46	Population: 6,700 1/3 the annual natural background exposure
	0.01	3.94	Population: 15,000 Same dose as 2 round trip cross-country flights (cosmic radiation)

Release location: West of The Civic Center, San Francisco, CA
37° 46’ 44” N 122° 25’ 22” W

Winds near surface 10-15 mph from West.

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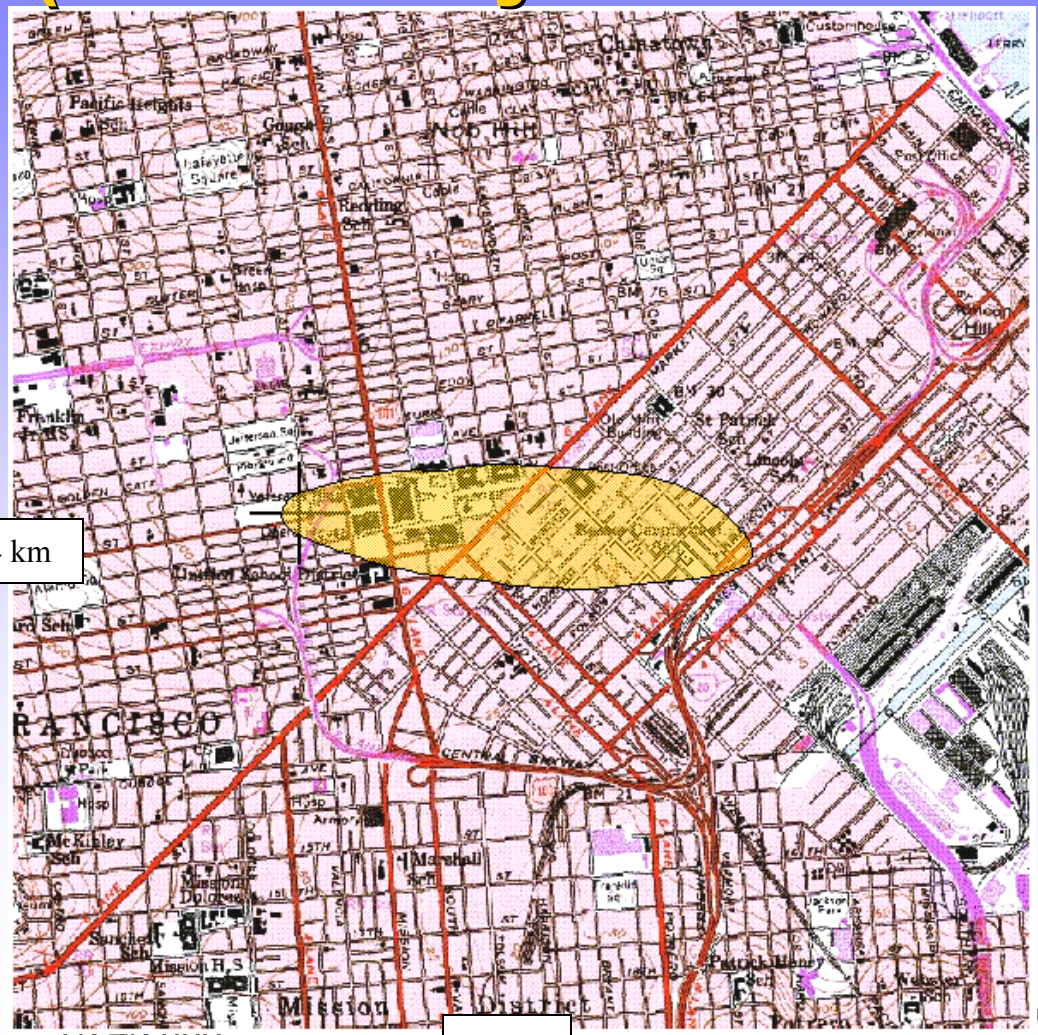
Area that the population would need to be relocated because the annual dose > 5 rem (without any remediation of contamination)



Release: Cs-137,
1375 Ci aerosolized
1-Year Relocation PAG from Ground shine

HYPOTHETICAL

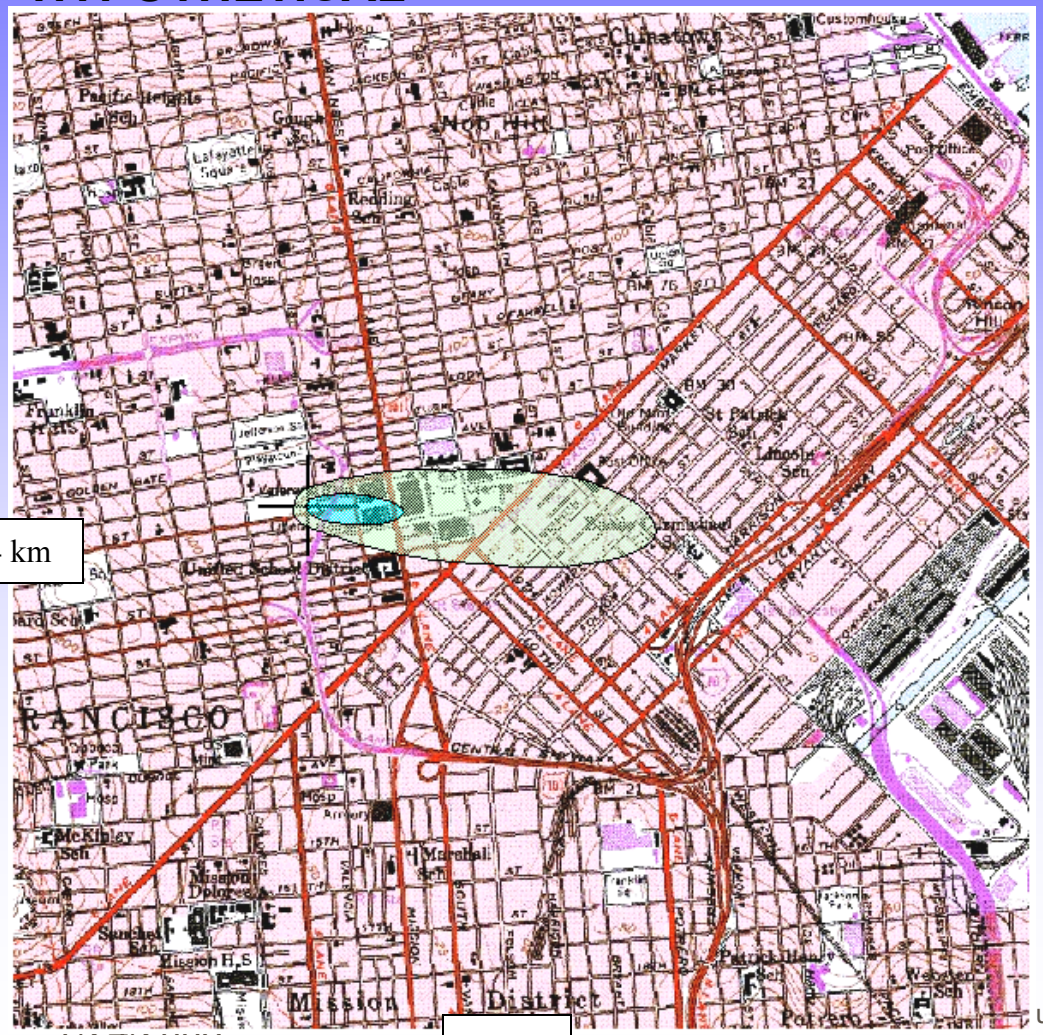
Color	Level (Rem)	Area (km^2)	Description
	5	0.72	Population: 9085 First Year Relocation PAG

Release location: West of The Civic Center, San Francisco, CA
37° 46’ 44” N 122° 25’ 22” W

Winds near surface 10-15 mph from West.

Dose Rates that will be seen by initial responders.

HYPOTHETICAL



HYPOTHETICAL

Release: Cs-137, 1375 Ci aerosolized
Gamma Dose Rate

Color	Level (mR/hr)	Area (km^2)	Description
	10	0.04	Population: 39 Consider Dosimetry for extended operations.
	1	0.5	Population: 772 Easily measured dose rate

Release location: West of The Civic Center, San Francisco, CA
37° 46’ 44” N 122° 25’ 22” W

Winds near surface 10-15 mph from West.

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Site Contamination

The previous slides presumed 100% of the source material went "upward." It is more realistic that more than half of the material will remain <u>at the explosion site</u>.

This <u>might</u> create:

- High Dose Rates at the scene (> 1 R/hr)
- Highly contaminated "blast" victims
- An inhalation concern for responders

Note: These issues can be safely managed and should not result in delayed medical care of the victims

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Even with Protective Clothing, RADIATION Can Still be a Hazard

- Hazardous radiation can occur from
  - High Levels of Contamination (ground shine)
  - A poorly distributed source (hot spots)
  - Intact sources (or pre-distribution)

- NCRP-138 "Management of Terrorist Events Involving Radioactive Material" recommends first responder "turn back" radiation levels of:
  - 10 R/hour, or
  - 10 rem total dose

(Note: responders can safely work at these levels if their exposure is monitored and work activities planned)

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DO NOT delay treatment of Medical Emergencies For Radiological Concerns

- Stabilize and remove medical emergencies from the scene
- Decontaminate patients only if stable

"Gross Decon" (removal of outer clothing) removes most of the contamination

Patients can also be wrapped in blanket to prevent spread of contamination

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Response to a Radiological Incident ~ Contamination ~

- Evacuate and "gross decon" victims (removal of outer clothing is an effective gross decontamination method)
- Monitor and isolate contaminated area
- Avoid breathing in radioactive material
  - Shelter in place (close windows, turn off heating and A/C)
  - Evacuate, when safe to do so
  - Wear respiratory protection

- Radioactive material will not be uniformly distributed. Radiation "Hot Spots" near the source of the event will be a hazard.

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Additional Steps to Mitigate High Contamination Hazards in the Immediate Area of a Release

- Approach and establish hotlines upwind
- Reduce Resuspension
  [Resuspension is the process of ground and plant contamination becoming airborne through the action of wind and/or activity]
  - Avoid activities that stir up dirt (driving, sweeping, etc..)
  - Apply "Fixative" (firefighting foam or even just misting water upwind of the site)

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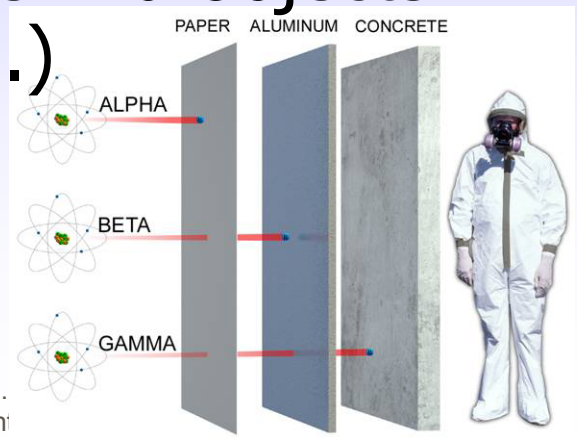
Response to a Radiological Incident
~ Radiation ~

- Time: Limit the time spent in an area of high radiation
- Distance: Exposure decreases dramatically as you increase your distance from the source.
- Shielding: Radiation is blocked by mass. When practical, operate behind objects (fire trucks, buildings, etc..)



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Conclusion:
First Responder Considerations

- Acute health effects from radiation dose are unlikely without prolonged, high-concentration exposure.
- Contamination readily detectable at long distances.
- Medical emergencies take precedence over radiological monitoring.
- Wear respiratory protection, isolate area.
- Use decontamination techniques (removing outer clothing most effective)
- **Call for assistance**

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